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SIMULATION, GAMING, AND CONVENTIONAL INSTRUCTION:

AN EXPERIMENTAL COMPARISON

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INTRODUCTORY STATEMENT

The Center for Social Organization of Schools has two primary objectives: to develop a scientific knowledge of how schools affect their students, and to use this knowledge to develop better school practices and organization.

The Center works through five programs to achieve its objectives. The Academic Games program has developed simulation games for use in the classroom. It is evaluating the effects of games on student learning and studying how games can improve interpersonal relations in the schools. The Social Accounts program is examining how a student's education affects his actual occupational attainment, and how education results in different vocational outcomes for blacks and whites. The Talents and Competencies program is studying the effects of educational experience on a wide range of human talents, competencies, and personal dispositions in order to formulate -- and research -- important educational goals other than traditional academic achievement. The School Organization program is currently concerned with the effects of student participation in social and educational decision-making, the structure of competition and cooperation, formal reward systems, effects of school quality, and the development of information systems for secondary schools. The Careers and Curricula program bases its work upon a theory of career development. It has developed a self-administered vocational guidance device to promote vocational development and to foster satisfying curricular decisions for high school, college, and adult populations.

This report, prepared by the Academic Games program, compares the effectiveness of various methods of teaching ecological principles.

ACKNOWLEDGMENTS

This study is the result of the active participation, comments and suggestions not only of the Academic Games Program staff, their assistants and spouses, but of many other individuals as well. We wish we could name them all. Special mention must be made, however, of the valuable contributions of Roger M. Imus, Market Planner, Coca-Cola Bottling Company of Baltimore, for making the Ecology Kits available; A. E. Pickhardt, Vice President, Marketing Services, Coca-Cola Company U.S.A., for granting us permission to reproduce portions of the Teacher's Manual for the Ecology Kit; Michael Inbar, former Director of the Academic Games Program, for his guidance and direction which generated the design for this large scale study; James S. Coleman, Professor of Social Relations, The Johns Hopkins University, for his assistance in conceptualizing the game structure for the modified version of the "Make Your Own World" simulation exercise; Sister Dennis Edward whose interest in innovative techniques and educational research were responsible for our obtaining the population for the study and for our being given the freedom to organize and conduct the study as we saw fit; Phyllis K. Wilson, secretary, for keeping up with the crash deadlines we gave her; Walter Gienapp, Principal of the Harford Christian School, for allowing us to test drafts of the game and questionnaires in his school before we distributed them to the teachers in our study; and Virginia Edwards and Diana Sack for their assistance with the clerical tasks associated with the collection and analysis of the data.

Special thanks and appreciation go to the 87 teachers, in the 47 schools, who actually taught the unit, administered the tests, coded the data and returned the materials to us on schedule; and to the 4539 students who immersed themselves in the study of ecology for two weeks.

ABSTRACT

An environmental problems unit was organized to be taught with three approaches. One approach contained two simulation exercises, one contained a simulation game and a simulation exercise, and one contained no simulations. These approaches were compared for their effectiveness for teaching facts and relationships and for producing favorable attitudes. An experiment involving 60 classes at the 3rd, 4th, and 8th grade levels showed the three treatments to be equally effective.

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INTRODUCTION

This paper presents the findings of an experiment that compared the effectiveness of a simulation exercise, a simulation game, and conventional instruction at the elementary and junior high school levels. Their effectiveness was compared for teaching facts and concepts related to ecology and the problems of population and pollution, for teaching the social and economic relationships that result in pollution, and for promoting attitudes favorable toward attempts to solve some of the problems of pollution.

The subject of pollution was selected because of the availability of the simulation kit, Man in His Environment, which was to be distributed free of charge to schools in the Baltimore area by the Coca-Cola Bottling Company of Baltimore. This kit contains materials for two simulation exercises. The first, entitled "Rescue in Space," is intended to teach the concept of a closed system and thus to illustrate the fact that Earth's resources are limited. The second, entitled "Make Your Own World," is intended to teach the interdependence of man and his environment. The kit also includes a teacher's manual which contains considerable background information as well as directions for administering the simulation exercises. The following brief descriptions of the two simulations are taken from the teacher's manual.

> At the beginning of "Rescue in Space," the teacher selects eight children as astronauts. They are divided into two groups of four, and after entering their "spaceships," they blast off for Mars. The remainder of the class is divided into four Ground Control teams. During the space voyage, they discuss with the astronauts the use of the air, food, water and living space in the spaceships. The astronauts and the Ground Control teams both have simple, written materials to help them conduct their discussions. Upon landing on Mars, one of the ships is

disabled; its occupants have to transfer to the remaining ship. The children then discuss the problems of using their air, food, water and living space under these new, crowded conditions. Finally, the remaining ship blasts off on its return trip to Earth, ending the exercise.

"Make Your Own World" is played on an illustrated board which simulates a geographical area containing forests, farms, rivers, and urban areas. At the beginning of the exercise, each student is assigned a role. It may be a human role, such as a store owner or a farmer; or it may be an animal role, such as a fish or a deer; or it may be a basic resource role, such as air or soil. The students are presented with a series of proposals about adding various man-made features to the board, such as an airport and a shopping center. The children discuss the possible consequences from the viewpoint of the roles they are playing. If a majority of the class votes to add the feature, a model of it is placed on the board, along with a given number of "Population Squares." These squares represent additional people who will move into the area because of the construction. Throughout the exercise and after it's over, the teacher can initiate discussions about the interrelationships of man with his environment: for example, if the group has voted to build everything proposed, all the farmland will have been erased. Where, then, will the food come from? Where is the oxygen to come from? Where is the town's water supply? Are there any natural areas for fish, wildlife, and nature lovers?

Neither of the simulation exercises in Man in His Environment is a game. However, the materials for "Make Your Own World" were used to create an environmental simulation game based on the "Prisoner's Dilemma" (Rapoport and Chammah, 1965); that is, a situation in which each person's individual interest is opposed to the collective interest. This model coincides neatly with Hardin's (1968) interpretation of the social causes of environmental pollution:

> "The rational man finds that his share of the cost of the wastes he discharges into the commons is less than the cost of purifying his wastes before releasing them. Since this is true for everyone, we are locked into a system of 'fouling our own nest,' so long as we behave only as independent, rational, free-enterprisers."

We decided to convert "Make Your Own World" into a simulation game for two reasons. First, the competitive nature of the game might produce greater involvement on the part of the students, which would lead in turn to greater learning. Second, the social and economic relationships described above were not present in "Make Your Own World," but are nevertheless important factors in the problems of pollution. In this revised version of "Make Your Own World," all the students represent persons living in the area represented on the board. They are divided into ten teams, each representing a special interest group, such as the Department of Highways or a manufacturing company. Each team decides whether or not to build a specific project (for example, the Department of Highways decides whether or not to build a super highway). Each team begins the game with 35 points. A team gains 8 points by building its own project, but <u>all</u> the teams lose a point for each harmful environmental effect of the project. Any team with 30 or more points at the end of the game is considered a winning team. Since most of the projects have two or three harmful environmental effects, if each team builds its project, all teams will lose.

The present study can be considered a test of the relative effectiveness of three approaches to teaching ecology in terms of the following learning outcomes:

1. Knowledge and application of facts and concepts specifically included in the simulations.
2. Knowledge and application of facts and concepts <u>not</u> specifically included in the simulations but included in the teacher's resource materials.

3. Understanding of the social and economic relationships that result in pollution.
4. The development of attitudes favorable toward attempts to solve pollution problems.

The experimental hypotheses were that, for objectives 1, 3, and 4, the unit containing the simulation game would be more effective than the unit containing only the simulation exercises, which in turn would be more effective than the unit containing no simulations. For objective 2, the unit containing no simulations was expected to be at least as effective as the others, because in the other units, the simulation exercises would require part of the limited amount of time to be devoted to the unit.

Several previous studies have compared simulation with conventional instruction, yielding mixed results. For teaching facts, Boocock (1966) and Baker (1968) found simulation to be more effective; Garvey and Seiler (1966) and Boocock, Schild, and Stoll (1967) found conventional instruction to be more effective; and Wing (1966) and Anderson (1970) found the two methods to be about equally effective. For changing attitudes, Baker (1968) and Lee and O'Leary (1971) found simulation to be more effective than conventional instruction, while Garvey and Seiler (1966) found no consistent difference between the two methods. These results are presented in Table 1. To the authors' best knowledge, there have been no research studies comparing the effectiveness of simulation games with that of simulation exercises that are not games.

TABLE 1

Summary of results of previous studies comparing simulation with conventional instruction.

Study	Simulation	More Effective Treatment	
		For teaching facts	For changing attitudes
Anderson (1970)	Consumer	no difference	
Baker (1968)	original simulation (U.S. history)	simulation	simulation
Boocock (1966)	Life Career	simulation	
Boocock, Schild and Stoll (1967)	Life Career, Democracy	conventional	
Garvey and Seiler (1966)	Inter-nation	conventional	no consistent difference
Lee and O'Leary (1971)	Inter-nation		simulation
Wing (1966)	Sumerian Game, Sierra Leone	no consistent difference	

METHOD

The subjects for the present study were 1,874 students in 60 third, fourth, and eighth grade classes in Catholic parochial schools in the Baltimore area. Classes at other levels also participated in the study, but not in sufficient numbers to justify their inclusion in the analysis of the results.

The experimental unit was not the individual student, but the class. In cases in which a teacher taught more than one class of students, only the earliest-meeting class was included in the analysis of the results. Classes were randomly assigned to treatments, subject to the restriction that within any one school all classes were to be assigned to the same treatment. All teachers participating in the study had volunteered to participate in a study to compare the effectiveness of various methods of teaching ecology.

The three experimental treatments will be referred to in this report as "Control," "Simulation Exercises," and "Simulation Game." The teachers in the Control group were given a resource booklet[1] containing all the information in the materials for Man in His Environment, but with all references to the simulation exercises deleted. The booklet also contained a bibliography of supplementary resource materials. The teachers in the Simulation Exercises group received the resource booklet and a copy of Man in His Environment, (hereafter referred to as "the Ecology Kit"). The teachers in the Simulation Game group received the resource booklet, the Ecology Kit, and a set of rules for converting "Make Your Own World" into a simulation game.

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[1] See Appendix A.

All the teachers in the three groups were instructed to use the materials provided as the basis for a teaching unit of ten 45-minute class periods, to be taught during a specified two week period. Teachers in the Simulation Exercises and Simulation Game groups were also asked to use each simulation exercise at least once and to try to use the exercises as much as possible. Teachers in the Simulation Game group were asked to use only the modified version of "Make Your Own World." Each teacher completed a brief "Description of Lesson" form for each of the nine class periods of instruction in the unit. (The tenth class period was reserved for testing.) No teacher was informed of the existence of any experimental treatment other than the one he himself was teaching. The experimenters met with the teachers in each treatment group separately and wrote three separate versions of each letter or set of instructions to the teachers - one version for each treatment group.[1] The teachers were asked not to discuss the experiment with anyone until it was over, and there is no evidence to indicate that any of them did discuss it.

The effectiveness of the three experimental treatments was measured by means of an objective test and questionnaire, given on the tenth and final day of the unit. Two different tests were used: Test 1, for grades 3, 4, and 5; and Test 2, for grades 6, 7, and 8.[2] Some test

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[1] See Appendix B. For both convenience and easy identification, whenever separate instructions or forms were required, they were color coded. Materials for the Control group were printed with green ink; for the Simulation Exercises group, with purple ink, and for the Simulation Game group with black ink. The extra amount of time and effort required was justified when a "black" form appeared in our "purple" group orientation meeting. The teacher, a junior high school teacher, graciously left thinking that she had come to the meeting for the elementary school teachers; she attended the correct meeting the following week, unaware that the study involved different treatments.

[2] See Appendix C for a copy of Test 1 and Appendix D for Test 2.

items (including all five attitude items) appeared on both tests; others appeared only on one of the tests. The factual items were designed to test the students' knowledge of facts and concepts and their ability to apply them. Some of these items tested information found in both the Ecology Kit and the resource booklet; others tested information found only in the resource booklet. The items were classified into these two categories before the experimenters had any knowledge of the results.

RESULTS

Since the unit of analysis for this experiment was the class, the analysis of the results was based on class mean scores. The mean scores reported in Table 2 are unweighted means of class mean scores. An inspection of these means shows the differences between groups to be small. In general, the 4th graders did better than the 3rd graders on the fact items. No comparison can be made between the 8th grade and the other two grades on either group of fact items, since the 8th graders took a different test.

A multivariate analysis of variance was conducted on each set of classroom mean scores, using a computer program that computes a least-squares solution for designs with unequal cell frequencies (Finn, 1968). The data for the 3rd and 4th grades were analyzed together; the data for the 8th grade were analyzed separately. These two analyses showed only one statistically significant multivariate effect - a difference between the third and fourth graders ($p < .013$). Three separate univariate analyses showed this effect to be the result of the superiority of the fourth graders on the fact items included in the simulation ($p < .0015$), which accounted for 26 percent of the variance in the class mean scores on that variable. Neither set of scores showed any significant multivariate effect involving the treatment variable.

Table 2

Mean Scores: Percent of Total Possible Score

	Control	Sim. Ex.	Sim. Game
Fact items in simulation			
3rd grade	.79	.78	.77
4th grade	.83	.84	.81
3rd and 4th combined	.81	.81	.80
8th grade	.75	.75	.75
Fact items not in simulation			
3rd grade	.77	.71	.70
4th grade	.76	.74	.73
3rd and 4th combined	.77	.73	.72
8th grade	.81	.79	.77
Attitude items			
3rd grade	.95	.89	.89
4th grade	.89	.83	.92
3rd and 4th combined	.91	.85	.91
8th grade	.89	.89	.85
Economic relationships			
8th grade only	.63	.57	.65

DISCUSSION

The most striking feature of the results is the small size of the differences among the three treatment groups. These differences not only fall short of statistical significance; they are so small as to be of no practical significance. For all practical purposes, the three treatments were equally effective.

But what did the treatments actually consist of? What was actually happening in the classrooms during the unit? Inspection of the teachers' description-of-lesson forms shows that two kinds of activities were used much more often by the control teachers than by the Simulation Exercises and Simulation Game teachers.[1] The control teachers used more films and filmstrips and more science experiments and demonstrations. In effect, these are the types of activities with which the simulations were being compared. Thus our results indicate that students learn about as much from the simulations in Man and His Environment as from films and science experiments selected by their teachers. In fact, one 4th grade Simulation Exercises class that played the simulations for all nine days of instruction scored slightly above average on both sets of fact items and well above average on the attitude items.

These results should encourage the teacher who wants to use simulation exercises in his classes. However, they may be less encouraging for school administrators and curriculum designers. Giving

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[1] See Appendix E.

the simulation materials to the teachers had no effect on the students' learning, and changing one of the simulation exercises into a simulation game did not change the effectiveness of the unit (although the scores on economic relationships do suggest a slight difference). Our experimental treatments involved about the same amount of control over the teachers that is usually exercised by supervisors and department chairmen; we provided the teachers with some resource materials and a list of objectives. While the limited nature of the treatments in our experiment permitted considerable uncontrolled variation in the teachers' choice of activities and teaching styles, this kind of variation is a fact of the real world of education.

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APPENDIX A

COPY OF RESOURCE BOOKLET

Field Test Materials
March 1971

ECOLOGY UNIT RESEARCH STUDY

RESOURCE BOOKLET

Center for Social Organization
of Schools
The Johns Hopkins University
3505 North Charles Street
Baltimore, Maryland 21218

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Grateful acknowledgment is made to the following for their assistance in the preparation of this Resource Booklet:

1. The Coca-Cola Company, for permission to reprint excerpts from Man in His Environment © 1970.

2. Miss Hocker, Librarian, The State Curriculum Center of the Maryland State Department of Education, for locating materials which were useful in the preliminary research for this booklet.

3. The librarians of the University of Chicago Laboratory School, for guidance in locating instructional resource materials.

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OVERVIEW OF THE UNIT

Although Earth's resources are limited, some can be re-used and some cannot. For example, fossil fuels cannot be re-used. When you burn a lump of coal, it is "gone" forever.

Other resources, such as air and water, can be re-used, or as ecologists say, recycled. There is a constant, natural recycling of the air we breathe, as plants convert into oxygen the carbon dioxide that animals exhale.

If the natural system becomes overloaded or breaks down, serious consequences can ensue. Thus, if the plant population is reduced below the point at which it can create enough oxygen to enable existing animals to survive, then the animal population will be reduced.

For mankind, then, a major problem is: how shall we use our resources most intelligently?

PURPOSES OF THE UNIT

The purposes of the unit are to develop an understanding of the following ecological principles:

1. The resources of the planet Earth are limited. To achieve a stable world, we must learn to use our resources wisely, and to re-use them where possible.

2. All elements of the environment are interrelated and interdependent. When man changes the environment, it has consequences not only for himself, but for other forms of plant and animal life, and for the soil, air, and water.

DURATION OF THE UNIT

The unit is designed to be taught during a two-week interval. It will take approximately ten (10) class periods.

ECOLOGICAL BACKGROUND INFORMATION FOR TEACHERS

I. WATER

A. Why is water important to life?

1. The human body contains 65-70% water.
2. Water does these things:
   a. Dissolves body chemicals.
   b. Aids digestion.
   c. Regulates body temperature through evaporation.
   d. Keeps interiors of lungs moist.
   e. Constitutes most of our blood.
   f. Lubricates joints and heart.
   g. Is needed for excretion of body wastes.
3. We should drink about eight glasses (64 oz.) per day; the ordinary diet provides part of this daily requirement.

B. How much water do you use each day?

1. When you include only the water required to grow the food you eat, it takes 2,500 gallons per day to maintain one adult life.
2. When you include washing, industrial uses, toilets, air conditioners, etc., the average person uses about 15,000 gallons per day.
3. Consider how much you waste.

C. Is our supply of water unlimited?

1. The supply can't be measured. Oceans make up three-fourths of Earth's surface.
2. Desalinization of salt water is becoming more practical, and may add to our supply.
3. Instead of dumping polluted water into our waterways, we can purify and re-use it.

D. Can we get more fresh water?

1. We can "make" rain by seeding clouds. However, this doesn't create new water; it just quickens the cycle.
2. We can dig wells and dam streams.
3. Every new answer creates new problems which will have to be faced:
   a. Over-irrigated and over-fertilized land can become desert.
   b. Dams can cause silting, earthquakes, or changes in fish life, etc.

II. FOOD

A. How much food do you need each day?

1. The average adult needs between 2,100-2,900 calories per day.
2. Elementary school children need more (2,500-3,000), and teenagers need most of all.

B. How do we use our food?

1. It's used in the body for growth, work, and maintenance. Even sleeping and sitting require calories.
2. Some food is used by livestock, pets, and wild animals.

C. Is there enough food on Earth now to feed everyone?

1. No. Over two billion people in the world are not properly fed.
2. We would have to double the world's food production to bring the population up to minimum nutrition standards.

D. Can we get more food on Earth?

1. Most farmable land is already used to grow crops; additional land can be made to support crops.
2. New food varieties have been developed to feed more people. Scientists are working on developing foods from other sources.
3. To grow more food, we need more machinery, irrigation, fertilizers, energy (fuel), and education for farmers. This presents new problems which take time to be solved.

E. Can we re-use our food?

1. Once energy is used for growth, maintenance, warmth, work, and play, it is "lost" forever.
2. We can give some food wastes to animals or put it back into soil as nutrient.
3. Digested food (human and animal waste) may be used for fertilizer, but no way has been found to recycle garbage into food.

III. AIR

A. How much air do you need each day?

1. The average person requires about 60 cubic feet per day.
2. The more carbon dioxide in the air, the harder it is to breathe.

B. Where does clean air come from?

1. A blanket of life-supporting fresh air surrounds the Earth; its height at various points ranges from about 4 3/4 miles to 11 miles.
2. Green plants are our "oxygen-making machines." They absorb carbon dioxide (CO_2) and turn it into oxygen by photosynthesis.
3. Small plants in the ocean also produce much of our oxygen.

IV. LIVING SPACE

A. How much land area is there on Earth? How is it used?

1. There are about 52 million square miles, ½ of the planet. Some of it, such as desert, mountain tops, and frigid zones, is uninhabitable.
2. People are distributed unevenly around the globe. In North America, there are now about 26 people per square mile; in Europe, 233; in Asia, 177.
3. Forest lands make up 32% of the U.S., 28% is used for grazing, 20% for growing crops, 8% for cities, 12% is desert, mountains and tundra.
4. 70% of the population of the U.S. lives in cities greater than 50,000.

B. Can we gain or lose land space?

1. Man has been filling in swamps, channeling rivers, covering land with cement, filling in bays, and rearranging things around him for many years to improve his standard of living. However, this frequently disturbs the balance of natural plant and animal life.
2. We lose many acres of topsoil through air and water erosion. What is being done about it? What can be done about it?
3. Some of man's activities make land useless, but with proper planning it can be reclaimed.

C. How much land does one average American require to maintain his present standard of living?

1. About 1½ acres supply him with food (including meat, vegetables, and fruit) as compared to an Asian who uses only two-thirds of an acre.
2. Another acre is required for his fibers (cotton, wool, and wood).
3. Two acres are used for each man's open space, air, and water, and for outdoor recreation.
4. Another one-half acre is used for his house, road, and other artificial structures.
5. Much more land is used for the automobile, especially in cities. Interstate highways also take up space. One highway lane can transport 3,600 people per hour in cars, while buses and trains can carry 12 to 17 times that number.

D. What changes can we make in the way we live that could help improve our use of space on Earth?

1. Improve central city space through better land use. This will require more careful planning and cooperation of individuals, business, and government.
2. Encourage people to move to areas where there is still sufficient room.
3. Build better mass transit systems.

V. QUALITY OF LIFE AND A LOOK TOWARD THE FUTURE

A. Can we keep up our standard of living? How about other nations?

1. The U.S. consumes more resources than any other nation.
2. As population grows, there is a need for more energy to run more machines to manufacture more goods.
   a. Our supply of fossil fuels, such as oil and coal, is limited.
   b. Atomic energy may be widely used in the future but it, too, creates problems which we shall have to solve.
   c. Although U.S. population doubles only every 60 years, demand for electricity doubles every 10 years.
   d. We can cut down on our energy consumption, but many may be unwilling to take this drastic step.
3. For other nations to achieve our standards, we may well put a strain on the Earth's limited resources. This will present new problems as we search for new resources and alternate materials. It means, too, that recycling of previously wasted materials will become more critical.

B. What can we do today to face and help solve problems of the future?

1. Man can learn to recycle his own products just as nature recycles air, water, minerals, nutrients, etc.
2. The average American throws away 5.3 pounds of garbage each day, some of it re-usable.
   a. We can re-use a lot of items, such as bottles, in their original form. Is there anything else that can be re-used?
   b. Glass can be crushed and turned into such things as pavement.
   c. Last year 11 million tons of paper were recycled. One ton of recycled paper saves 17 trees. However, we recycle only one-fifth of our paper products.
   d. Aluminum and steel can be recycled. There is a greater concentration of aluminum ore in city dumps than is found in the ground.
   e. Used oil can be re-refined.
   f. More research must be done on the subject of recycling. People will not bother to return and re-use items until it becomes economically justified.
   g. Each of us can help in little ways such as keeping our streets, our neighborhoods and our schools free of litter, and reminding our friends and families that we want a clean and beautiful environment.

VI. GLOSSARY

The following glossary contains explanations of a number of words commonly used by ecologists. Many of the words, such as "community" and "population" have other, non-ecological meanings. Here, only the ecological definition is given.

Biomass: noun: the amount of living matter in an area. It is usually expressed as the weight of the organisms per unit area, or as the volume of the organisms per unit volume of habitat.

Biosphere: noun: that part of the atmosphere and of the Earth's surface where life can exist.

Biotic: noun: pertaining to life.

Carnivore: noun: an organism which eats animals. A "top carnivore" eats other carnivores.

Channel, Channelize: verb: to straighten and dredge a stream or make it into a canal.

Climax: noun: the stage at which a plant or animal community becomes mature and can maintain itself.

Community: noun: a group of interrelated plant and animal populations occupying a common area. (See "Population")

Consumer: noun: an organism that eats other plants or animals. (See "Carnivore," "Herbivore")

Dam: noun: a wall across a stream that stops or controls the flow of water.

Decomposer: noun: an organism that breaks down the bodies or parts of other plants and animals into simpler substances. Decomposers are usually bacteria or fungi which rot living or dead material.

Diversity: noun: a condition or state characterized by many different kinds of plant and/or animal life in a given area. It is also a measure of the variety of plants and/or animals in a given area.

Dredge: noun: a machine for removing earth from the bottom or sides of a river or other body of water. verb: to clear out or excavate streams, ponds, etc.

Ecology: noun: the science which deals with the relations between plants and animals, including man, and their environment.

Energy Flow: noun: the flow of energy from the sun (the source of all the Earth's energy) through plants and then through animals which consume the plants and which are, in turn, consumed by other animals. (See "Food Chain")

Environment: noun: the sum of living and non-living things in a given area, including plants, animals, people, air, water, and soil.

Ecosystem: noun: a system created by the interaction of a community and its environment.

Food Chain: noun: a series of organisms which consume each other in sequence, e.g., plants are eaten by small mice, which are in turn eaten by foxes.

Habitat: noun: the place where an animal or plant lives.

Herbivore: noun: an organism that eats plants.

Hydroelectric Dam: noun: a dam which converts running water into electric power.

Irrigation: noun: the spreading of water over land in small ditches or canals to help provide water for crops.

Limiting Factor: noun: any factor that tends to slow down or stop potential growth of a particular population in an ecosystem, or that restricts the presence or the activities of an organism.

Litter: noun: scattered rubbish or trash; any materials which have become useless to us and with which we thoughtlessly clutter our cities and landscape.

Monoculture: noun: in agriculture, the use of land for only one crop; any single-organism community.

Pollution: noun: the presence of any materials, or heat, or noise, in quantities that make them harmful or undesirable.

Population: noun: all the individuals of one species living in a given area.

Producer: noun: an organism, such as a plant, that creates its food from non-living materials, and provides food for others.

Recycle: verb: to treat anything in such a way that, instead of being wasted, it is made useful, e.g., dirty water can be recycled or purified so that it becomes fit for drinking; old paper can be recycled or reprocessed so that it becomes the equal of new paper.

Reservoir: noun: a place where water is collected and stored.

Succession: noun: the process in which a climax is established by the replacement of one community with another.

SUGGESTED TOPICS AND QUESTIONS FOR DISCUSSION

I. Main Idea: The resources of the planet earth are limited
The following questions may be useful in helping students understand the concepts underlying this main idea, particularly the concept of (the earth as) a closed system.

A. Water

1. How much water do you actually need each day? For what purposes is the water used?
2. If you used up your supply of water, could you get more?
3. Does recycled water have a different taste?
4. What is done with human waste?
5. Can we recycle any of the human waste water for other uses?
6. Can we reduce the amount of water we use each day? How?

B. Food

1. How many pounds of food do you need each day?
2. Do you have to eat that much food every day in order to stay healthy?
3. How much food needs to be produced to satisfy each person's minimum daily requirements?
4. Is there any way to increase our food supply?

C. Air

1. How much air do you breathe each day?
2. When do you use the greatest amount of air?
3. When do you use the least amount of air?
4. Is there any way to make more air available to each person?
5. Why hasn't all the air been used up by now?
6. Would it be possible to use up all the air?
7. Is there any way to store air?

D. Living Space

1. How much living space does each person require for his activities?
2. For what things is living space used?
3. What is the minimum amount of living space a person might live in?
4. How do you think people would feel towards each other if they were forced to live in a confined environment for a few months? How might they express these feelings?
5. How does population growth affect the amount of living space? (You may want to relate the following: Thousands of years before the birth of Christ, the doubling time of the world's population was about 1,000 years. About 1850, around the time of the American Civil War,

the doubling time was only 200 years. At the time of the great economic depression, around 1930, the doubling time was reduced to only 80 years. Right now, the doubling time is 37 years. This means that by the time the class is in its 40's, there will be twice as many people. Many countries have doubling times of much less than this; others are growing at a slower rate.

II. Main Idea: All elements of the environment are interrelated and interdependent.

A. In weighing the advantages and disadvantages of man's changing the environment, students should consider the economic, social, political, and ecological arguments. Examples of ways in which the environment could be changed and the possible economic, social, political, and ecological results are given below. Remember that whenever the population of the area increases we will have to expand our sewage disposal facilities and provide new trash dumps.

1. If we build a hydroelectric dam and reservoir
   a. The dam will make electricity for the area.
   b. The dam will prevent the river from flooding.
   c. The building of the dam will provide jobs for people who live in the area.
   d. The dam will let the flow of water into the river be controlled. This will cause many changes downstream in the river.
   e. The reservior will provide a large supply of fresh water.
   f. The reservior will bring tourists and fishermen into the area. They will spend money on such things as motel rooms, gasoline, and food.
   g. People can go boating, fishing, and waterskiing.
   h. The reservior will allow growth of a recreational boating industry in the area. Stores nearby will sell boats and equipment.
   i. Some land which was used for other purposes (e.g., farmland, forest land) will be placed under water and will no longer be available for those purposes.
   j. Some people will be able to build homes on the lake. The population will increase.

2. If we create a wildlife preserve
   a. The natural park will be an area of forest, woods, and streams.
   b. Camping facilities will be built.
   c. Families will be able to enjoy out-of-doors.
   d. It will create a natural habitat with woods and streams for the future, and it will guarantee a home for wildlife and fish.
   e. There can be no more hunting and fishing in the area. But there will be hiking, birdwatching, camping, and swimming.
   f. It will bring in more visitors, which means more motels, restaurants and gas stations in areas outside the park. The population in the area will increase.
   g. It removes the possibility of further development of that area. No homes, factories, or stores can ever be built there.

h. There will be no admission charge; anyone can enter.
i. No cars, trucks, or motorcycles can be driven into or through the park, but there will be large parking areas outside the park where visitors can leave cars and trailers.
j. Because of large numbers of people visiting in the area, there will probably be increased problems of litter.
k. Tax money will be used to create and maintain this area.

3. If we build a marina
   a. The marina will provide a place for people to moor their boats.
   b. It will provide recreation along the water--boating and fishing.
   c. It will spur the growth of some new businesses.
   d. It will increase the number of jobs in the area. New stores will be built to take care of boater's needs, and there will be more gas stations and restaurants in the area; people will be hired to work in them. The population in the area will increase.
   e. Gas, oil, and sewage from the boats may pollute the water. Trash may be thrown into the water.
   f. People living in the area will find it more convenient to store their boats, and keep them well maintained.
   g. Dredges will have to deepen the water body to let in larger boats. This may cause some mud and silt to form, and may kill some fish.
   h. More people will make greater use of the water, and more people will be able to enjoy recreation along the water.
   i. Some trees must be cleared to build along the water's edge. We must build a road and a place to park cars at the marina.

4. If we build an auto speedway
   a. The auto speedway will provide recreation for people in the area who enjoy watching and driving in auto races.
   b. It is a new business designed to make money and to create more jobs. It will help the area to grow. The population in the area will increase.
   c. The speedway will increase the number of tourists coming into the area. This means a few more jobs for people who live in the area.
   d. On racing days, fumes from the cars will pollute the air.
   e. Noise from the racing cars will be heard in the immediate area.
   f. The speedway will replace land which was used for other purposes.
   g. The speedway will pay taxes to the community. We can use this money to pay for other improvements.
   h. People will enjoy watching the races.
   i. The land where the speedway is built can be sold for a profit.
   j. On racing days, restaurants and motels will have increased business because of the large crowds. Many stores will also benefit from these crowds.

5. If we build an amusement park
   a. The amusement park will provide recreation for all the children and their parents in the area. The park will contain rides, swimming, shooting galleries, a fun house, and so on.
   b. It is a new business designed to make money and to create more jobs. It will help the area to grow.
   c. The people who own the land will be able to sell it.
   d. The park will be noisy; people who live near it will probably think it's an eyesore.
   e. It will provide jobs for workers and may employ some high school students.
   f. It will destroy some trees in the area; but some new trees will be planted.
   g. The ground will be covered with asphalt and concrete. Rain will run quickly off it. In a heavy rain, this may increase the chance of a flash flood.
   h. It will be a fun place to go during the evenings and on the weekends.
   i. Machines that operate the rides may add to air pollution.
   j. It will bring in more money. The taxes it pays will help us make other improvements in our area.

6. If we build an airport
   a. The airport will provide fast transportation for people and products moving into or out of the area.
   b. Our area will grow and will be tied closer to other communities. It will bring more and richer commerce to us.
   c. There will be more jobs. People in the area will be hired to run the airport.
   d. There will be more money in the community, because more people will be working.
   e. More businessmen will want to set up companies in the area because they will be able to receive and ship goods more quickly.
   f. People who live nearby will be able to travel in and out of the area more easily and quickly.
   g. Planes flying into the area will create more noise.
   h. Parking areas will be built for visitors at the airport. This will bring more cars into the area.
   i. Our town may get more tax money from the airport and businesses to use for other improvements.
   j. The population will increase.

7. If we build a super highway
   a. The super highway will make it easier for cars and trucks to drive into and out of the area.
   b. We will be able to save a lot of time in driving to other places. And it will be safer than other types of roads.
   c. There will be more jobs. People will be hired to build the highway. But, the highway will be built with tax money. After it's completed, gas stations, motels, and restaurants will be built near it; people will be hired to work in them.

d. There will be more money in the community, because more people will be working.
e. The highway will make it easier to receive and ship goods. So, there will be more businesses coming into the area, which means even more jobs for people.
f. People who own the land along the highway may be able to sell it.
g. The highway will bring more cars and trucks into the area. This will add to air pollution.
h. The population will increase.
i. Land that was used for other purposes will no longer be available for those purposes.
j. The highway will replace some trees and plants. So there will be slightly less oxygen produced. But, we will plant shrubs and more trees along the highway.

8. If we build an industrial park

a. The industrial park will be a place where companies will make toys, bicycles, furniture, books, and soft drinks.
b. It will provide new businesses and opportunities. The community will grow through more money and more jobs.
c. People in the area will be hired to work in the new businesses and industries.
d. There will be more money in the community because more people are working.
e. New businesses will be paying taxes.
f. Companies here will make products people want and need.
g. Much of the area will be paved or have buildings on it; trees will be cleared, but new ones will be planted.
h. More cars will be in the area. It will add to air pollution.
i. Products and goods made locally may be cheaper and more plentiful because they are not shipped a long way.
j. Businesses will grow because we can sell our goods in other areas.
k. Many people will move into the area.

9. If we build high rise apartments

a. The high-rise apartments will permit a lot of people to live in a small area.
b. They provide newer and better homes for more people.
c. They will be a new business and will bring more money to the community.
d. The apartments will let a lot of people live in a small area. This means that the ground they might otherwise take up if they had separate homes can now be used for other purposes, such as parks, industries, and stores.
e. Building the apartments will provide jobs for many workers. It also gives them a place to live.
f. They will provide newer homes and can offer some recreation areas to the residents--swimming pools and game rooms.

g. Children living here will not have large yards to play in and parents will not have to spend time cutting the grass.
h. Building the apartments will bring more money into the area--maintenance services will be needed; the community will get tax money from the residents and the apartment owners.

10. If we build a shopping center

a. The shopping center will provide convenient shopping for people who live in the area.
b. Additional businesses will create more money; city stores can branch out into new areas.
c. The shopping center will need store managers, clerks, and many other kinds of people to run it. So there will be more jobs.
d. There will be more money in the community, because more people will be working.
e. The stores in the shopping center will be selling many kinds of products to people in the area. Without the shopping center, it would be difficult for people in the area to buy these products.
f. The shopping center will make it possible for some stores to sell products at lower prices.
g. People in the area will go to the shopping center instead of driving to the city. This means that they'll be driving shorter distances. Their cars will burn less gasoline, and so, there will be less air pollution.
h. The population in the area will increase.

B. A discussion of the interrelationship of man with his environment might focus upon the ways in which changes such as those described above would affect the food supply, the oxygen supply, the water supply, and the natural areas for fish, wildlife, and nature lovers.

1. If we cut down on farmland would it make any difference in the amount of food available?

2. What difference does it make to man, or to other animals, or to the plants and the soil, if woodland is eliminated?

3. What effects do changes (give examples) have on the plants, animals, and natural features?

4. What responsibility does man have to take into account the air, water, soil, plants, and animals when he considers whether or not to change the environment?

   a. Although we know that certain animals are important to man for his food, what difference does it make if there is little or no wildlife?
   b. What kinds of animals would you <u>like</u> to be able to see by taking just a short drive from here? What kinds <u>would</u> you see?
   c. If you had the power to do anything you wanted, how would you like to change our town so that you could see these animals by taking a short walk or drive to their natural homes?
   d. Where do man's air and water come from? If we developed our whole earth, would we still have enough air and water?
   e. In the community where we live, who makes decisions about what will or will not be built? Do all the people have a part in making all the decisions all the time?
   f. Is voting always the best way to make decisions about how land and water should be used? What are other methods?

INSTRUCTIONAL RESOURCES

I. SUPPLEMENTARY READING MATERIALS

A. For Children and Young People

Aylesworth, Thomas G. This Vital Air This Vital Water: Man's Environmental Crisis. Rand McNally, 1968.

Chandler, T. J. The Air Around Us: Man Looks at His Atmosphere. Natural History Press, 1969.

Davies, Delwyn. Fresh Water: The Precious Resource. The Natural History Press, 1969.

Fisher, Tadd. Our Overcrowded World. Parents' Magazine Press, 1969.

Harrison, C. William. Conservationists and What They Do. Watts, 1963.

Harrison, C. William. Conservation: The Challenge of Reclaiming Our Plundered Land. Julian Messner, 1963.

Hilton, Suzanne. How Do They Get Rid of It? Westminster, 1970.

Hitch, Allen S., and Sorenson, Marian. Conservation and You. D. Van Nostrand, Co., 1964.

Laycock, George. America's Endangered Wildlife. Norton, 1969.

Laycock, George. Wild Refuge. The Natural History Press, 1969.

Lewis, Alfred. Clean the Air! McGraw-Hill, 1965.

Munzer, Martha E. Pockets of Hope. Alfred A. Knopf, 1967.

Navarra, John Gabriel. Our Noisy World. Doubleday, 1969.

Perry, John. Our Polluted World. Watts, 1967.

Pinny, Roy. Wildlife in Danger. Duell, Sloan and Pearce, 1966.

Pringle, Laurence. The Only Earth We Have. Macmillan, 1969.

Russell, W. M. S. Man, Nature and History: Controlling the Environment. The Natural History Press, 1969.

Scott, John. Hunger: Man's Struggle to Feed Himself. Parents' Magazine Press, 1969.

Shuttlesworth, Dorothy E. Clean Air--Sparkling Water: The Fight Against Pollution. Doubleday, 1968.

Van Dersal, William R. The Land Renewed. Henry Z. Walck, 1968.

Wood, Frances and Wood, Dorothy. Animals in Danger. Dodd, Mead and Company, 1968.

B. For Teachers

1. Historical Roots of Environmental Conservation

Nash, Roderick (ed.). The American Environment, Readings in the History of Conservation. Addison Wesley, 1968.

Udall, Stewart. The Quiet Crisis. Holt, Rinehart and Winston, 1963.

2. Ecology, Natural History

Bardach, John. Downstream. Harper and Row, 1968.

Bardach, John. Harvest of the Sea. Harper and Row, 1968.

Bates, Marston. The Nature of Natural History. (Revised ed.) Scribner's, 1950.

Cox, George W. (ed.) Readings in Conservation Ecology. Appleton-Century-Crofts, 1969.

Kormondy, Edward J. Concepts of Ecology. Prentice-Hall, 1968.

Krutch, Joseph Wood. The Great Chain of Life. Pyramid Books, 1966.

Odum, Eugene P. Ecology. Holt, Rinehart, and Winston, 1963.

Shepard, Paul and McKinley, Daniel (eds.) The Subversive Science: Essays Toward an Ecology of Man. Houghton-Miflin, 1969.

Storer, John H. The Web of Life. The Devin-Adair Co. (Also in Signet Science Library paperback.) 1963.

3. Environmental Overview

Appleyard, Donald; Lynch, Kevin; and Myer, John. The View from the Road. M.I.T., 1963.

Carson, Rachel. Silent Spring. Houghton-Mifflin, 1962.

Caudill, Harry. Night Comes to the Cumberlands. Little, Brown & Co., 1962.

Dasmann, Raymond. A Different Kind of Country. Macmillan, 1965.

Dasmann, Raymond. Environmental Conservation. John Wiley and Sons, 1959.

Dasmann, Raymond. The Destruotion of California. Macmillan, 1965.

De Bell, Garett. The Environmental Handbook. Ballantine Books (paperback), 1970.

Ehrlich, Paul. The Population Bomb. Ballantine Books, 1968.

Mannix, Daniel P. Troubled Waters. Dutton Press, 1969.

Marine, Gene. America The Raped. Simon and Schuster, 1969.

Marx, Wesley. The Frail Ocean. Coward-McCann (also in a new, Ballantine/Sierra Club paperback), 1967.

Rienow, Robert and Train, Leonara. Moment in the Sun . Dial Press (also in Ballantine/Sierra Club paperback), 1967.

Udall, Stewart. 1976: Agenda for Tomorrow. Holt, Rinehart, and Winston, 1969.

4. Philosophical Basis

Commoner, Barry. Science and Survival. Viking Compass Paperback, 1963.

Dubos, Rene. So Human An Animal. Doubleday and Charles Scribner's Sons, 1969.

Heckscher, August. The Public Happiness. Atheneum, 1962.

Heilbroner, Robert. The Future as History. Evergreen Press, 1959.

Leopold, Aldo. The Sand County Almanac. (There is also a newer edition including essays from Round River) Oxford University Press, 1949.

Michael, Donald. The Next Generation. Vantage Press, 1963.

Michael, Donald. The Unprepared Society. Vantage Press, 1969.

5. Symposia, Proceedings, Essay Collections

American Academy of Arts and Sciences, "America's Changing Environment," Daedalus (Fall, 1967).

Smithsonian Institution, The Fitness of Man's Environment. Smithsonian Institution Press, 1967.

Environment for Man: The Next Fifty Years. William Ewald (ed.), Indiana University Press. American Institute of Planners 50th Anniversary Conference (paperback), 1968.

Environment and Change: The Next Fifty Years.
William Ewald, (ed.) Indiana University Press, 1968.

Environment and Policy: The Next Fifty Years.
William Ewald, (ed.) Indiana University Press, 1968.

The Environment: A National Mission for the Seventies. Editors of Fortune, Perennial Library/Harper & Row (paperback), 1970.

6. Government Documents*

Task Force on Environmental Health and Related Problems. A Strategy for a Livable Environment 1967 U.S. Department of Health, Education, and Welfare (paperback, GPO 60¢)

Environmental Pollution Panel, President's Science Advisory Committee. Restoring the Quality of our Environment. 1965 The White House (paperback, GPO $1.25).

National Academy of Sciences (ad hoc Panel on Technology Assessment). Technology: Processes of Assessment and Choice 1969 (Prepared for Committee on Science and Astronautics, U.S. House of Representatives, Washington, D.C. 20515).

Joint House-Senate Colloquium To Discuss a National Policy for the Environment. Hearing before the Committee on Interior and Insular Affairs, U.S. Senate and Committee on Science and Astronautics, House. 90th Cong., 2nd sess. July 11, 1968 (Request from either Committee Chairman).

A National Policy for the Environment. Report of the Subcommittee on Science, Research, and Development to the Committee on Science and Astronautics, U.S. House of Rep. 1968.

II. AUDIO-VISUAL MATERIALS

The following list is by no means exhaustive or representative of the currently available audio-visual materials. It is included here to provide help for teachers whose access to such materials is limited.

A. Films

1. The Community, Encyclopedia Brittanica, 1962. 11 minutes, color, 16 mm. Examines three different ecological communities (pine forests, grasslands, intertidal).

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*Items marked "GPO" are available at the price indicated from Superintendent of Documents, Government Printing Office, Washington, D.C. Simply list items wanted by title. Valuable informational documents may also be available from Senators or Congressmen having committee chairmanships in this field.

2. Pond Life, Encyclopedia Brittanica, 1950. 11 minutes, black and white, 16 mm. Depicts the pond as an organized community in which plants and animals are dependent upon each other.

3. Population Ecology, Eneyclopedia Brittanica, 1964. 19 minutes, color, 16 mm. Examines factors which limit the growth of plant and animal populations in their natural environments. Explains how man's success in controlling his environment has affected the growth rate of the human population.

4. The Physical Environment, Encyclopedia Brittanica, 1963. 11 minutes, color, 16 mm. Shows how living things adapt to changes in their environment.

B. Filmstrips

1. The Living Desert--The Great American Desert, (Disney Studios), Encyclopedia Brittanica.

2. Natives of the Park, Curriculum Films.

3. Natives of the Everglades, Curriculum Films.

4. Natives of the Desert, Curriculum Films.

5. The Swamp--Some Relationships Between Organisms, Encyclopedia Brittanica.

6. Around the Water, Eyegate Studios.

7. Desert Life Community, Curriculum Films.

8. Seashore--Continually Changing Environment, Encyclopedia Brittanica.

III. SOURCES FOR FREE OR LOW-COST INFORMATIONAL MATERIALS ON POPULATION, CONSERVATION AND ECOLOGY

Zero Population Growth 367 State Street Los Altos, California 94022	Newsletter, brochures, ecology leaflets, reprints.
Population Reference Bureau 1955 Massachusetts Ave., N.W. Washington, D.C. 20036	Good bibliography, source list, and film guide on population. Minimal cost.
National Wildlife Federation 1412 - 16th Street, N.W. Washington, D.C. 20036	Conservation Directory--a guide to all state and national sources of conservation and environment information. $1.50. Informational packets on ecology and pollution--special packets from elementary to adult level. Monthly newsletter.

American Association of University Women 2401 Virginia Avenue, N.W. Washington, D.C. 20037	Resource directory on pollution control. $.75 Anti-pollution pamphlets and study guide. $.75
National Parks Association 1701 - 18th Street, N.W. Washington, D.C. 20036	Free or low-cost pamphlets and articles on thermal pollution noise pollution, pesticides, and basic ecology.
Conservation Foundation 1250 Connecticut Ave., N.W. Washington, D.C. 20036	Variety of pamphlets and articles dealing with the many aspects of ecology.
Sierra Club Mills Tower San Francisco, Calif. 94104	List of publications, pollution, population information, protection of scenic areas.
Project Man's Environment National Education Association 1201 - 16th Street, N.W. Washington, D.C. 20036	Information on curriculum (K thru 12) environmental study areas.
Isaac Walton League of America 1326 Waukegan Road Glenview, Illinois 60025	"Clean Water --- It's Up to You" -- pamphlet on what local citizens can do about water pollution. Free. Monthly conservation newsletter.
Environment Magazine 438 N. Skinker St. Louis, Missouri 63130	Monthly publication dealing with effects of technology on the environment, published by Committee for Environmental Information. Student subscription -- $5.00 year
Public Affairs Pamphlets 381 Park Avenue South New York, New York 10016	Pamphlet #421 - "An Environment Fit for People" - $.25 Pamphlet #403 - "The Battle for Clean Air" - $.25
Portland Center for Continuing Education P.O. Box 1491 Portland, Oregon 97207 Attn: Mr. Lawless	"Observing our Environment," - $3.00, relating elementary students to environment.

APPENDIX B

COPIES OF INSTRUCTIONS AND FORMS USED

ECOLOGY UNIT RESEARCH STUDY

Description of Lesson

Teacher: _____

School: _____

Grade: _____ Class: _____

Lesson Number: _____ Date of Lesson: _____

Time of Lesson: (From)_____ (To) _____

Materials Used:

Please summarize briefly the purpose(s) of this lesson and the teaching method(s) used.

Center for Social Organization of Schools
The Johns Hopkins University
3505 North Charles Street
Baltimore, Maryland 21218

ECOLOGY UNIT RESEARCH STUDY

Class Summary of Ecology Test Results

Teacher _____

School _____

Grade _____ Class (indicate identifying code) _____

Date test given _____

Test Used Test #1 ( ) Test #2 ( )

Test Corrected by _____

Directions:

1. Print the names of the students who took the test.
2. Circle the numeral beside the student's name if he missed two or more classes of instruction during the two weeks of the study. (For example, (3) John Doe).
3. Read the directions for completing the class summary on the "Instructions for Administering the Test, Scoring the Test, and Recording the Test Results."
4. Fill in the student's scores for the individual test items.
5. Return the completed summary and the tests in the envelope provided.

Center for Social Organization of Schools
The Johns Hopkins University
3505 N. Charles Street
Baltimore, Maryland 21218

ECOLOGY UNIT RESEARCH STUDY

FIELD TEST INFORMATION

Please complete the following and return to us at the meeting on _____.

Name _____

School Name (Full Name) _____

School Address _____
Street

_____
City State Zipcode

School Telephone Number _____

Information about the class(es) to which you will teach the Ecology Unit.

Please provide the following information under each of the headings below:

Class. Identify each different class or section. Use a letter, or numeral. For example, 8A, 8B.

Grade. Indicate the grade level.

Number of Students. Indicate the number of students in each class.

General Ability. If classes are ability-grouped, write "high," "high-average," "average," "low-average," or "low." If class contains students of all ability levels, write "mixed."

Subject. Identify the subject(s) you generally teach to the class. For example, all subjects, Earth Science, Social Studies, etc.

	Class	Grade	Number of Students	General Ability	Subject(s) Taught
1.					
2.					
3.					
4.					
5.					

Teaching Schedule. Please indicate, for the class(es) to which you will teach the Ecology Unit, the time of day, or period, you will teach the unit. (If you teach more than one class, or section, use the same identifying number you used above to identify the class, or section.) Please teach the unit 45 minutes per day during the two weeks.

Time of Day

Monday							
Tuesday							
Wednesday							
Thursday							
Friday							

Additional Comments. Please add any additional information you feel we should have about your teaching schedule.

"Control" Group

Center for Social Organization of Schools
The Johns Hopkins University
3505 North Charles Street
Baltimore, Maryland 21218

ECOLOGY UNIT RESEARCH STUDY

Summary of Orientation Meeting

March 17, 1971

The Center for Social Organization of Schools is one of eight centers funded by the U.S. Office of Education. The Center has two primary objectives: to develop a scientific knowledge of how schools affect their students, and to use this knowledge to develop better school practices and organizations.

The Center works through five programs to achieve its objectives. Comparisons of the effectiveness of various pedagogical techniques is the focus of one of these programs; the purpose of the present study is to compare the effectiveness of various methods of teaching ecology.

Instructions for Teaching the Unit

In order to keep the research conditions as similar as possible for all teachers and students participating in the study,

1. You must teach the Ecology Unit during the two-week period beginning April 19 and ending April 30. Please do not discuss ecology or the study with your class before April 19.

2. You must teach the Ecology Unit to the classes you indicated on the first Information Sheet you returned to us. If you teach classes at more than one grade level and you were requested (in the letter announcing the meeting) to teach the unit to the classes at certain grade levels (e.g., only to your Grade 4 students), please teach the unit only to those classes during the study. When the study is completed, you may teach the unit to your other classes.

3. You must teach ecology for forty-five (45) minutes (no more, no less) each day of the study, except April 30--the date on which the test is to be administered.

For these two weeks ecology should replace the unit which would ordinarily be taught during the social studies period or the science period, or both.

If you use ecology as the theme of a lesson in another subject area (e.g. art), you should consider the amount of time spent as part of the required forty-five minutes.

If your social studies or science period is only twenty (20) or twenty-five (25) minutes long, you should arrange your schedule so that you teach two ecology-related lessons per day. The lessons do not both have to be social studies or science lessons.

If you usually give your students home lesson assignments, you may make such assignments for the Ecology Unit. The time students spend at home on such assignments is not to be considered as part of the forty-five minutes of classroom instruction.

4. You must not discuss the study or the Ecology Unit with anyone else until all the data (tests and "Description of Lesson" forms) have been collected (around May 15). In some of the schools represented in the study, there are several teachers participating; in others, there is only one. Therefore, to make conditions as similar as possible for all teachers, we want to minimize the effects of interaction.

5. You should use whatever teaching methods you would ordinarily use, given the ability and background of your class. The material contained in the Resource Booklet outlined the topics which the unit should cover. Specific lessons were not developed so that you would use the methods you would ordinarily use.

6. You must complete a "Description of Lesson" form for each lesson you teach during the study. If you teach the same lesson to more than one class, only one "Description of Lesson" form needs to be completed for the lesson. However, you must indicate the identifying code, the lesson numbers, and the time for each class to which you taught the lesson.

   You should write a short summary describing the previous experiences or instruction, if any, your class has had in ecology. This information will help us to interpret the study's findings.

   If you plan to use materials more than once, you may make a master list describing the materials in as much detail as possible. (For example, a bulletin board display; author, title, etc. for textbooks.) You can identify it by using code or an abbreviation under the section labeled "Materials used."

   Although the general purposes of the unit are described in the Resource Booklet, your specific purpose(s) for the lesson should be indicated for each daily lesson.

You should describe as completely as possible the methods you used to teach the lesson. This information is needed for the analysis of the data from the study. Home lesson assignments should also be described.

You should try to complete the "Description of Lesson" forms at the conclusion of the day on which the lesson is taught.

7. You must administer the tests on Friday, April 30. The tests will be mailed during the final week of the study. To avoid the temptation to teach the test, you should not open the envelope containing the tests until April 30. (The tests will be mailed in a brown envelope similar to the one in which the Resource Booklet was mailed.)

The Field Test Information Sheets should be completed and returned as soon as possible. We will need the information regarding class size to determine the number of tests to be duplicated and sent to each teacher.

You should feel free to telephone the Center (366-3300 ext. 1255) whenever you have a question, or if a situation arises which you wish to discuss with the research staff. It is possible that we may be away from the Center when you call; if so, you should leave both your school telephone number and your home telephone number so that we can return your call the same day.

We may request that teachers score the tests given at the conclusion of the unit. Scoring the tests may not otherwise be completed by the end of the school year. A letter explaining the testing procedure and an answer key will be mailed with the tests. Stamped, addressed return envelopes for the tests and the "Description of Lesson" forms will be mailed to you.

When the data has been analyzed and the final report has been written (some time next Fall), you will be invited to a meeting at which the staff's interpretation of the findings will be discussed. Each teacher who requests a copy of the report will receive one.

"Simulation Exercises" Group

Center for Social Organization of Schools
The Johns Hopkins University
3505 North Charles Street
Baltimore, Maryland 21218

ECOLOGY UNIT RESEARCH STUDY

Summary of Orientation Meeting

March 18, 1971

The Center for Social Organization of Schools is one of eight centers funded by the U.S. Office of Education. The Center has two primary objectives: to develop a scientific knowledge of how schools affect their students, and to use this knowledge to develop better school practices and organizations.

The Center works through five programs to achieve its objectives. The Academic Games program studies the processes through which games teach and evaluates the effects of games on student learning.

The purpose of the present study is to evaluate the effectiveness of teaching ecology by using the Ecology Kit, Man In His Environment, published by the Coca-Cola Company. The kit contains two simulations, Rescue in Space and Make Your Own World. These simulations were selected because they, unlike most simulation games, are designed to be used with elementary and junior high school students; to date, there has been little research done on simulations for elementary and junior high school students.

Instructions for Teaching the Unit

In order to keep the research conditions as similar as possible for all teachers and students participating in the study,

1. You must teach the Ecology Unit during the two-week period beginning April 19 and ending April 30. Please do not discuss ecology or the study with your class before April 19.

2. You must teach the Ecology Unit to the classes you indicated on the first Information Sheet you returned to us. If you teach classes at more than one grade level and you were requested (in the letter announcing the meeting) to teach the unit to the classes at certain grade levels (e.g., only to your Grade 4 students), please teach the unit only to those classes during the study. When the study is completed, you may teach the unit to your other classes.

3. You must teach ecology for forty-five (45) minutes (no more, no less) each day of the study, except April 30--the date on which the test is to be administered.

   For these two weeks ecology should replace the unit which would ordinarily be taught during the social studies period or the science period, or both.

   If you use ecology as the theme of a lesson in another subject area (e.g. art), you should consider the amount of time spent as part of the required forty-five minutes.

   If your social studies or science period is only twenty (20) or twenty-five (25) minutes long, you should arrange your schedule so that you teach two ecology-related lessons per day. The lessons do not both have to be social studies or science lessons.

   If you usually give your students home lesson assignments, you may make such assignments for the Ecology Unit. The time students spend at home on such assignments is not to be considered as part of the forty-five minutes of classroom instruction.

4. You must not discuss the study or the Ecology Unit with anyone else until all the data (tests and "Description of Lesson" forms) have been collected around May 15). In some of the schools represented in the study, there are several teachers participating; in others, there is only one. Therefore, to make conditions as similar as possible for all teachers, we want to minimize the effects of interaction.

5. You must use both simulations at least once during the two-week period. You should try to use them as much as possible during the two weeks (but only 45 minutes per day).

   The material contained in the Resource Booklet is also contained in the Teacher's Manual for the Ecology Kit. We reproduced this material because we only had enough kits to give one to each school and we wanted all teachers to have immediate and unlimited access to the information. The Resource Booklet also contains the information given on the forms and cards used with the simulations.

6. You must complete a "Description of Lesson" form for each lesson you teach during the study. If you teach the same lesson to more than one class, only one "Description of Lesson" form needs to be completed for the lesson. However, you must indicate the identifying code, the lesson number, and the time for each class to which you taught the lesson.

   You should write a short summary describing the previous experiences or instruction, if any, your class has had in ecology. This information will help us to interpret the study's findings.

   If you plan to use materials more than once, you may make a master list describing the materials in as much detail as possible.

(For example, a bulletin board display; author, title, etc. for textbooks.) You can then identify it by using code or an abbreviation under the section labeled "Materials Used."

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You should describe as completely as possible the methods you used to teach the lesson. This information is needed for the analysis of the data from the study. Home lesson assignments should also be described.

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The Ecology Kits have been made available to the schools through the generosity of the Baltimore area Coca-Cola Bottling Company (2525 Kirk Avenue). Each school may keep its kit after the study is completed.

"Simulation Game" Group

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The Johns Hopkins University
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March 25, 1971

The Center for Social Organization of Schools is one of eight Centers funded by the U.S. Office of Education. The Center has two primary objectives: to develop a scientific knowledge of how schools affect their students, and to use this knowledge to develop better school practices and organizations.

The center works through five programs to achieve its objectives. The Academic Games program studies the processes through which games teach and evaluates the effects of games on student learning.

The Ecology Kit, Man In His Environment, published by the Coca-Cola Company, contains two simulation exercises--Rescue in Space and Make Your Own World. We became interested in these simulation exercises because they, unlike most simulation games, are designed to be used with elementary and junior high school students; to date, there has been little research done on simulations for elementary and junior high school students. Each of the exercises has been tested by the developers at the University of Georgia.

The purpose of the present study is to evaluate the effectiveness of teaching ecology using a simulation game. Therefore, we have rewritten the directions for the simulation exercise Make Your Own World and have added game elements to it.

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5. You must use Rescue In Space at least once during the two-week period. You must use the Special Instructions for Make Your Own World at least once during the two-week period. (Do not use the instructions which are contained in the Teacher's Manual (in the Kit) for Make Your Own World.

   You should try to use both Rescue in Space and the Special Instructions for Make Your Own World as much as possible during the two weeks. (But no longer than 45 minutes per day.)

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Specific lessons were not developed so that you could use whatever methods, in addition to the simulations, you would ordinarily use, given the ability and background of your class.

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. TEST ITEM NUMBERS

Students' Names	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41	Final Score
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
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30.		

APPENDIX C

COPY OF TEST 1 (Grades 3, 4, and 5)

ECOLOGY TEST #1

Name _____

Teacher's Name _____

Grade _____

True or False

1. It doesn't matter how much fresh water there is, as long as everyone has enough to drink.

   ( ) True ( ) False

2. Water can be purified and re-used many times.

   ( ) True ( ) False

3. If all the countries in the world shared their food, there would be enough food for everybody.

   ( ) True ( ) False

4. The world is already producing all the food that it possibly can.

   ( ) True ( ) False

5. People take oxygen out of the air.

   ( ) True ( ) False

6. Cars take oxygen out of the air.

   ( ) True ( ) False

7. Animals put oxygen into the air.

   ( ) True ( ) False

8. Green plants put oxygen into the air.

   ( ) True ( ) False

9. Some of the land on earth cannot be used for living space.

   ( ) True ( ) False

10. The United States uses up more of the world's resources than any other country.

    ( ) True ( ) False

11. Buses and trains help save living space.

    ( ) True ( ) False

12. The United States has more unused living space than most other countries.

    ( ) True ( ) False

13. Most Americans use more electricity now than they did five years ago.

( ) True ( ) False

14. Cars cause air pollution.

( ) True ( ) False

15. Trees cause air pollution.

( ) True ( ) False

16. Laundry detergents cause air pollution.

( ) True ( ) False

17. Factories cause air pollution.

( ) True ( ) False

18. Cars cause water pollution.

( ) True ( ) False

19. Trees cause water pollution.

( ) True ( ) False

20. Laundry detergents cause water pollution.

( ) True ( ) False

21. Factories cause water pollution.

( ) True ( ) False

22. People can help stop pollution by not burning their papers and trash.

( ) True ( ) False

23. People can help stop pollution by returning their soda bottles.

( ) True ( ) False

24. People can help stop pollution by keeping their lawns cut.

( ) True ( ) False

25. People can help stop pollution by using their cars less.

( ) True ( ) False

26. People can help stop pollution by washing their hands before eating.

( ) True ( ) False

The Big City electric company plans to build a big dam to make electricity for Big City. The dam will be built on a river that runs through a forest thirty miles from Big City. If this happens, then:

27. There will be fewer floods.

( ) True ( ) False

28. There will be less air pollution in Big City.

( ) True ( ) False

29. Some of the land will be under water.

( ) True ( ) False

30. Fewer people will want to live in the area.

( ) True ( ) False

The next seven questions are about whether things can be re-used after they have already been used once.

31. Glass can be re-used.

( ) True ( ) False

32. Steel can be re-used.

( ) True ( ) False

33. Coal can be re-used.

( ) True ( ) False

34. Paper can be re-used.

( ) True ( ) False

35. Aluminum can be re-used.

( ) True ( ) False

36. Gasoline can be re-used.

( ) True ( ) False

For the last five questions there are no right or wrong answers. Just check yes or no to tell what you think.

37. Would you help your classmates collect paper for re-use?

( ) Yes ( ) No

38. Do you feel that your family can do something to stop pollution?

( ) Yes ( ) No

39. Would you read a book on ecology?

( ) Yes ( ) No

40. Does your family do things that cause pollution?

( ) Yes ( ) No

41. Do your classmates care about pollution?

( ) Yes ( ) No

Final Score

APPENDIX D

COPY OF TEST 2 (Grades 6, 7, and 8)

ECOLOGY TEST #2

Name _____

Teacher's Name _____

Grade _____

Check the space beside the best answer.

1. If all the countries in the world shared their food, there would be enough for everybody.

   ( ) True ( ) False

2. The United States uses up more of the world's resources than any other country.

   ( ) True ( ) False

3. The average American uses about the same amount of electricity now as he did five years ago.

   ( ) True ( ) False

4. Water can be purified and re-used many times.

   ( ) True ( ) False

5. Glass can be re-used (after it has already been used once).

   ( ) True ( ) False

6. Gasoline can be re-used.

   ( ) True ( ) False

7. Steel can be re-used.

   ( ) True ( ) False

8. Paper can be re-used.

   ( ) True ( ) False

9. Coal can be re-used.

   ( ) True ( ) False

10. Aluminum can be re-used.

    ( ) True ( ) False

The Big City electric company plans to build a big dam to make electricity for Big City. The dam will be built on a river that runs through a forest 30 miles from Big City. If this happens, then:

11. There will be fewer floods.

( ) True ( ) False

12. There will be less air pollution in Big City.

( ) True ( ) False

13. Some of the land will be under water.

( ) True ( ) False

14. Fewer people will want to live in the area.

( ) True ( ) False

Check the space beside the one best answer for each of the following.

15. The average American uses about 15,000 gallons of water per day. Most of this water is used

( ) for drinking and preparing food.

( ) for bathing.

( ) for growing the food he eats.

( ) for making the manufactured products he uses.

16. Does building dams to generate electric power help to reduce air pollution?

( ) Yes, because people who live near dams don't use their cars as much.

( ) Yes, because most other electric power plants pollute the air.

( ) No, because dams are far away from cities, where the pollution is.

( ) No, because the generators used in dams give off carbon monoxide.

17. Do buses and trains help save living space?

( ) Yes, because 40 people driving cars take up much more space than 40 people riding a bus or train.

( ) Yes, because people who ride buses and trains usually live in high-rise apartments.

( ) No, because buses and trains can't take each person exactly where he wants to go.

( ) No, because buses and trains are much bigger than cars.

18. Is the world already producing all of the food that it can possibly produce?

( ) Yes, because there isn't any unused farmland left.

( ) Yes, because the soil gets used up if you farm it too much.

( ) No, because new kinds of seeds and modern methods could grow more food on the same land.

( ) No, because it is possible to recycle human and animal wastes into edible food.

19. Which sentence best describes a closed system?

( ) Nothing can come in.

( ) Nothing can go out.

( ) Nothing can come in or go out.

( ) Everything that goes in must go out.

( ) When something comes in, something else has to go out.

20. Is the earth a closed system with respect to air ?

( ) Yes ( ) No

21. Is the earth a closed system with respect to water?

( ) Yes ( ) No

22. Is the earth a closed system with respect to energy?

( ) Yes ( ) No

For questions 23-30 write either "OX" for oxygen or "CD" for carbon dioxide in the space.

23. People take _____ out of the air.

24. Animals take _____ out of the air.

25. Green plants take _____ out of the air.

26. Cars take _____ out of the air.

27. People put _____ into the air.

28. Animals put _____ into the air.

29. Green plants put _____ into the air.

30. Cars put _____ into the air.

For questions 31-35 there are not right or wrong answers. Just check yes or no to tell what you think.

31. Would you help your classmates collect paper for re-use?

( ) Yes ( ) No

32. Do you feel that your family can do something to stop pollution?

( ) Yes ( ) No

33. Would you read a book on ecology?

( ) Yes ( ) No

34. Does your family do things that cause pollution?

( ) Yes ( ) No

35. Do your classmates care about pollution?

( ) Yes ( ) No

Answer this question in <u>one or two short sentences</u>:

36. Suppose every factory that pollutes the air or water were forced to close down. Can you think of any bad things that would happen?

APPENDIX E

TABULATION OF TYPES OF TEACHING-LEARNING ACTIVITIES USED

PERCENTAGES OF TEACHERS USING EACH MEDIUM

	Control Group	Sim Game Group	Sim Ex Group
Lecture	77%	73%	52%
Chalkboard	29%	27%	29%
Discussion, etc.	94%	96%	67%
Paper/Pencil Task	58%	41%	19%
Magazines, Etc.	93%	73%	47%
Charts, Posters, Maps, etc.	93%	55%	29%
Films/Filmstrips	93%	46%	43%
Bulletin Boards	17%	36%	19%
Rescue In Space	---	96%	95%
Make Your Own World	---	100%	95%
Science Experiments	35%	9%	14%
Group Work	58%	32%	29%
Other*	94%	73%	52%

*This category includes field trips,art activities, overhead projectors, reading of textbooks, etc., oral reports, library research, etc.

CONTROL GROUP: Breakdown of Number of Times Teachers Used Various Media

Grade Level:	Lecture	Chalk Board	Discussion; Question and Answer	Paper/ Pencil Task	Magazines, Resource Books, Pictures, etc.	Charts, Posters, Maps, etc.	Films/ Film-Strips	Bulletin Boards	Rescue In Space	Make Your Own World	Science Experi-ments	Group Work	Other*
4			8		1	1	3	1					
8	2		7			2	6					2	1
3			2	3	1	5	5	1			3	2	3
8	5	1	6	5	2	2	2				2	1	6
3	1		6		1	2	8						1
3			4			2	2				1		1
4	3		5		7	2	3						2
8	4	4	3	1	1		3				3	1	4
3	1				3	2	4		DOES NOT APPLY	DOES NOT APPLY			3
8	5	1	5	3	4		1					2	3
4	1		6		6	4					1		1
8	1		4	3	3	2	2	2				3	4
8			4	1	3	4	3					3	4
4	2		1	2	4	2	6				1	1	4
8	4	5	5	2	1	1						2	4
4	3		9	2									1
4	2	1	3	2	2	3	2					1	3
Totals	34	12	78	24	39	34	50	4	-	-	11	18	45

SIMULATION EXERCISES GROUP: Breakdown of Number of Times Teachers Used Various Media

Grade Level:	Lecture	Chalk Board	Discussion; Question and Answer	Paper/ Pencil Task	Magazines, Resource Books, Pictures, etc.	Charts, Posters, Maps, etc.	Films/ Film-Strips	Bulletin Boards	Rescue In Space	Make Your Own World	Science Experi-ments	Group Work	Other*
3		1	5						1	3	1		
4	1	2			2		5	1	1				2
8		1	1		3		2	2	1	2			
4	1				2	2			1	3			
8			5							3			
4	3		3				2		2	2			
8			6		3		2	1	1	2		2	1
3	1		2		1	1	1		2	3			1
4					2				1	2		1	1
8	2	3	2	2	1	3			1	3			1
3	3		1	1				2	2	2			1
8	1		2						1	2			
4			3				3		1	1	3	2	2
8	2		1	1			1		2	4		1	1
8		1			1				1	3		1	3
3						2			1	4			
4									5	4			
8	2		4				3		2	2			
3	4		5		2	2			4	4			
8		1	2	2	2	1			2	2	1	2	5
8	3						4		1	3			1
Totals	23	9	42	6	19	11	23	6	33	54	5	9	19

SIMULATION GAME GROUP: Breakdown of Number of Times Teachers Used Various Media

Grade Level:	Lecture	Chalk Board	Discussion; Question and Answer	Paper/ Pencil Task	Magazines, Resource Books, Pictures, etc.	Charts, Posters, Maps, etc.	Films/ Film-Strips	Bulletin Boards	Rescue In Space	Make Your Own World	Science Experi-ments	Group Work	Other*
4	3	3	5	2	1			1	1	1			
8	1		1		1		2		1	2			2
4	1		2			1			3	3			1
3			3		2		3		2	2			
4	1		4	4	3	2	4	2	3	1	1	1	2
8			3				5		1	1			1
8	1		6	2	1	1		2	2	2	1	2	2
3	2		2	1	1	1	5		1	1		5	3
4	1		4			1	6	1	1	1			
4	1		2		2		2	1	2	2		1	1
4	1	1	3	1	1	1				1		1	3
4	1	1	7	2	1	2		1	1	1		1	3
8	4	2	4		3	1	2		1	1			1
4			1						4	4			3
8	3		4		1	1	2		2	1			1
4	2		4	1	2			2	3	1			3
3	3		3		2				2	2			2
4	1					2			2	2			3
3		1	3					3	2	2			
4	2	1	4	1	2	1			2	1		2	
8			3	1	3				3	2			1
3	2	1	5		1	1	5		1	2			
Totals	30	10	73	15	27	15	36	13	40	36	2	13	32

BREAKDOWN OF TOPICS COVERED BY EACH GROUP

Subjects Mentioned	Control Group	Simulation Exercises Group	Simulation Game Group
Water Pollution	27	28	29
Air Pollution	17	18	25
Food	16	15	17
Population	3	5	8
Noise Pollution	3	0	1
Living Space	9	9	9
Resource Depletion	2	7	6
Closed System	3	6	11
Recycling	2	8	8
Conservation of soil; land use; erosion	10	2	4
Solid Waste Disposal	3	1	2
Pollution as general topic	5	4	7
Conservation as general topic	5	4	7
Plants, animal, wildlife interdependence	6	3	6
Earth Day	3	2	2